Helicopter Health and Usage Monitoring Systems (HUMS)

Brian D Larder

Stewart Hughes Limited

Aviation Analysis Tools and Methods

Third GAIN World Conference

November 3-5, 1998

A History of HUMS

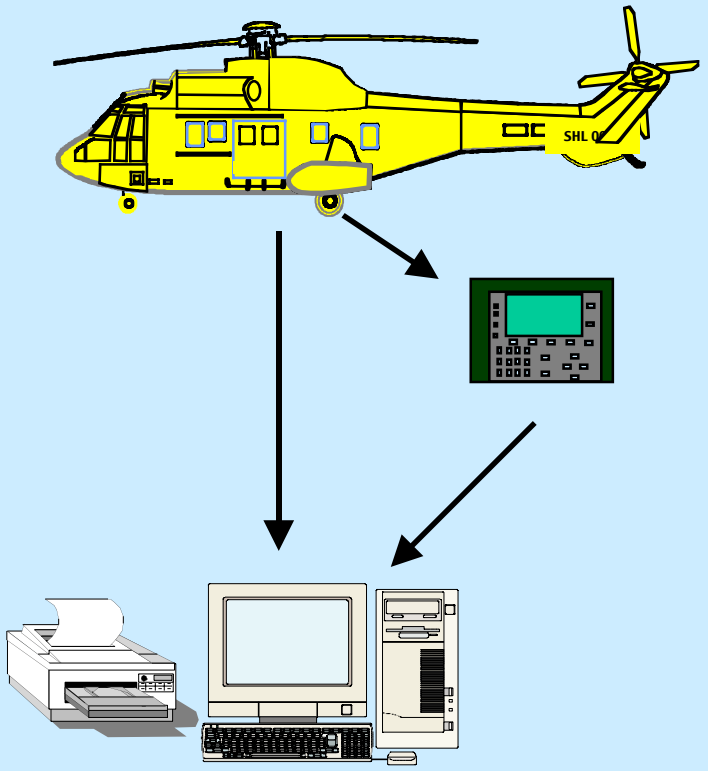
- Requirement - large UK public transport helicopters:
  - Perceived need to improve helicopter safety
  - Mandatory requirement for FDRs on existing aircraft
  - HUMS needed for certification of new aircraft
- Implementation:
  - HUMS developed and trialed in the UK in the 1980s
  - North Sea operators installed HUM/FDR systems in the early 1990s
  - HUMS then adopted by constructors and other civil/military operators

HUMS functions

- Rotor Track and Balance
  - Blade track, Vibration
- Engine Health Monitoring
  - Performance, Vibration
- Drive Train Health Monitoring
  - Vibration, Oil debris
- Usage Monitoring
  - Exceedance, Operational data, Usage spectrum
- Flight Data Recording

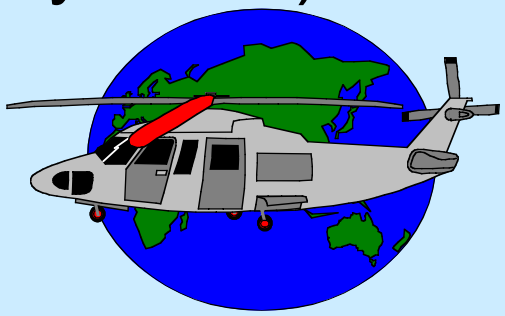
HUMS Outputs

- Output devices:
  - Flight line unit (RTB)
  - Ground Station (Maintenance)
- Outputs:
  - Reports and alerts
  - Data numerical displays
  - Data trend displays
  - ‘Raw’ data inspection



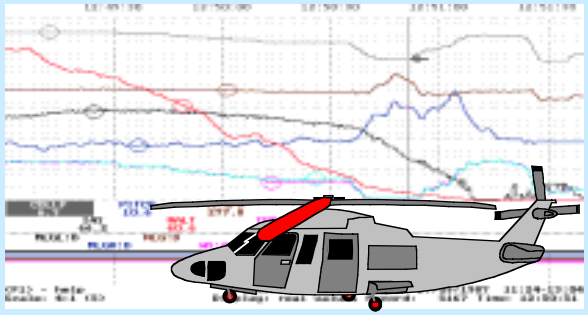
HUMS Data Analysis Support

- Operators - HUMS departments/specialists
- Constructors - HUMS departments
- Stewart Hughes - ILS Group:
  - Support to operators and constructors
  - Customer database reviews
  - Expert diagnostic support (enquiry forms)
  - Maintenance of a fault library
  - User conferences



HUMS - The Future

- Development of current functions
  - Maintenance credits, control of aircraft lifing
- New HUMS functions
  - Pilot assist, e.g. carefree handling
- New FDR functions
  - Enabling system for helicopter FOQA:
    - CAA research programme
    - Flight trials next year



HUMS In-service experience

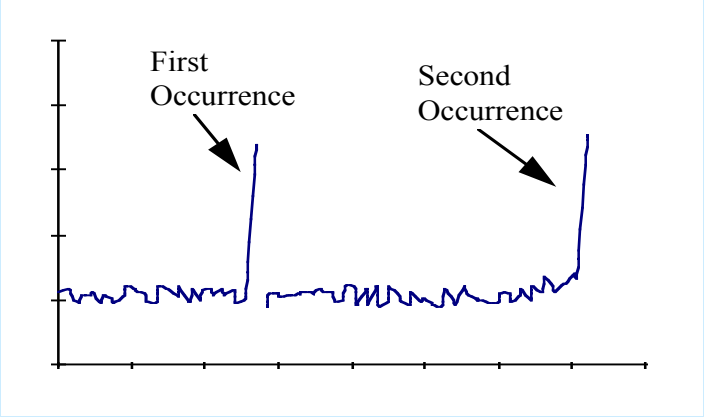
- HUMS is providing real safety benefits
- HUMS is becoming an effective maintenance support tool
- RTB operations have been simplified and airframe vibration levels reduced
- HUMS/FDR exceedance and incident data has prevented unnecessary component rejections

HUMS diagnostic performance

- CAA data on HUMS arisings - approximately:
  - 70% successful detections
  - 15% fault evident in data, but not detected
  - 15% failures
- SHL's HUMS database contains over 25 different types of drive train and rotor fault
- HUMS has successfully detected a wide range of both 'classical' and 'novel' faults
- Diagnosis of 'novel' faults relies on experience

Example of a ‘classical’ fault

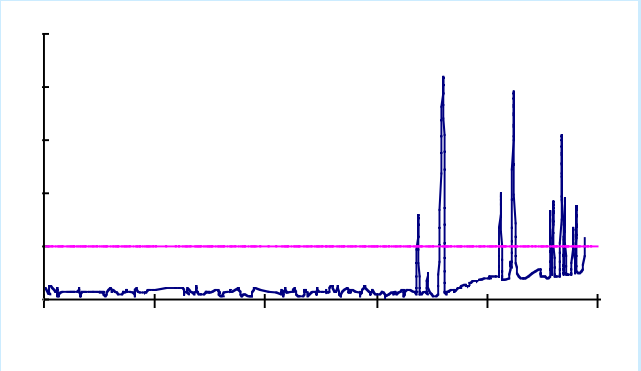
- Fatigue failure of a shaft coupling bolt
  - Alert on HUMS Data Retrieval Unit after download between flights
  - Large increase in shaft 1/rev vibration
  - Visual inspection of shaft identified a coupling bolt failure
  - Next flight cancelled



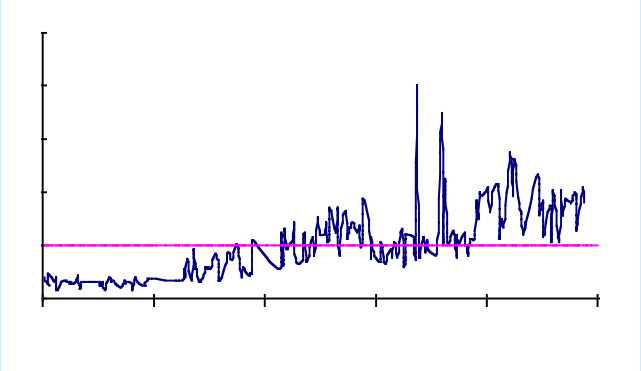
Shaft 1/rev vibration trend

Example of a ‘novel’ fault

- Circumferential crack in outer race of MGB bearing
  - Rising indicator trends with increased variability - trends tracked for period of time
  - Raw data inspected periodically - showed abnormal characteristics
  - Fault not diagnosed, but MGB rejected
  - Found large circumferential crack in shaft support bearing



Bevel gear indicator trend



Bevel pinion indicator trend

HUMS Issues

- **In common with other Aviation Analysis Tools:**
  - **HUMS has been breaking new ground, introducing new monitoring and diagnostic techniques**
  - **HUMS involves multiple organisations: System suppliers, Operators, Constructors and Regulators**
  - **The potential of HUMS is being limited by a lack of information exchange between these organisations**

The need for information

- HUMS suppliers
  - Need feedback to develop HUMS diagnostics
- Operators
  - Need effective HUMS-related maintenance procedures and advice
- Constructors
  - Need an understanding of HUMS to develop maintenance procedures and propose credits
- Regulators
  - Need confidence in HUMS to award safety and maintenance credits

Information Sources and Issues

- In-service data:
  - HUMS data (different systems, data owned by operators, sensitive data)
  - Operator maintenance data (no HUMS-specific records, sensitive data)
  - Overhaul data (different organisations, no general requirement for strip reports, sensitive data)
  - Accident/incident data (sensitive data, legal issues)
- Other data:
  - Test rig/validation data (ownership of data)
  - Conference papers (selectivity of information)

Information sharing

- Current activities:
  - HUMS supplier sharing experience between operators (SHL)
  - Constructor providing HUMS reports based on gearbox overhauls (Sikorsky)
  - Sharing of experience between operator, constructor and regulator (EuroHUMS CSI)
  - Conferences on HUMS experience (IMechE)
- Need mechanisms for wider sharing of de-identified data between all interested parties

Conclusions

- HUMS represents a major advance in helicopter monitoring technology
- HUMS is providing real safety and maintenance benefits
- There is potential for considerable future growth in HUMS capabilities and benefits
- The sharing of information is key to the realisation of this potential